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Evaluating the addition of photovoltaic panels on a listed building:

Does the integration of photovoltaics diminish or enhance the cultural significance of York Minster, in a society that progressively prioritises sustainability?

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ABSTRACT

The built environment plays a significant role within the discourse surrounding the climate change crisis, serving both as a contributor to carbon emissions and, paradoxically, as a progressive force to mitigate its impact. As the global climate change crisis becomes more pressing, the importance of sustainable intervention is rising, leading to intensified debates over the conflicting viewpoints regarding its implementation on listed buildings. Nonetheless, the evolution of listed buildings remains a contentious topic, with some advocating for changes to historical structures while others vehemently oppose such alterations. With the integration of photovoltaic panels being an example of a sustainable intervention on a listed building, an investigation into the impact this has on cultural significance provides an enhanced comprehension of people's perspectives towards the alteration of buildings with notable heritage value, particularly in a society that progressively prioritises the environment – helping to ensure a balance between sustainability and heritage preservation. The investigation was conducted through an analysis of the integration of photovoltaic panels onto the roof of York Minster, in which a historical lens was employed to assess the impact of previously completed interventions on the building, alongside an examination of the visual aspects of the panels. It was discovered that various interpretations of the impact on overall cultural significance can be understood as a result of the implementation, emphasising the subjectivity of cultural significance as a value-based concept. Furthermore, it was found that amid the backdrop of the global climate change crisis, the proactive measures undertaken by the organisations responsible for listed edifices to conduct building alterations with a focus on sustainability, where historically they sought simply to preserve, arguably underscores the collective failure of humanity to respond to the climate crisis with the urgency it demands.

Introduction

Change in the built environment is largely inevitable. Buildings in general are frequently altered in the face of a rapidly changing civilisation, which progressively responds to natural, technical and socioeconomical advances. The process of changing a historical, listed building is considerably more complex. The modification of these structures

regarding public safety is arguably of intergenerational consensus; however, intervention of a historical building that results in an incongruity, through forming something that did not previously exist, is a topic of legal matters. This is evident in the rigorous application process required to obtain planning approval for alterations to listed buildings, where failure to seek government permission is a criminal offence (UK Government, 1990). This is a process which seeks to protect, not eradicate the significance.

Unnecessary replacement of historic fabric, regardless how minimal the intervention, is widely believed to have an inimical effect on the appearance, value and authenticity of the building – arguably lessening its accreditation as a fount of historical information. This belief poses the idea that a lack of preservation diminishes shared identity, and remembrance of the past that an authentic historical building portrays as a symbol for man's previous accomplishments.

In contrast, some deem that enhancing a building to maintain its value aligns with a society increasingly focused on sustainability and the environment, thus potentially positioning it as a 'symbol for change', should the alterations to the building be made to combat the climate crisis. It is further argued that this concept of symbolism should work as a method of realisation for many individuals, highlighting the severity of the climate crisis through the visual elements of sustainable alteration to listed buildings.

There is a common 'misconception that "listing" a building, means to "freeze" it in its place and time' (Worthing, & Bond, 2008). Instead, 'listing' marks the observation of a building's notable architecture, material use and historical background that results in the desire to protect it for future generations – not to stifle change, but to ensure any alterations protect and enhance cultural significance. This investigation aims to expound the discretion that is surrounded by the topic of sustainably modifying listed buildings, posing the question: Can sustainable modification take place as to not diminish a historical building's cultural value, but to seamlessly transition it from past to present in such a way as to secure the transfer of maximum significance? This research is imperative for investigating whether existing buildings can or should be included as instruments in the ongoing crisis of preventing climate change, and not be excluded from sustainable alterations purely because they are 'listed'.

Utilising York Minster, The Metropolitan Church of St. Peter, as the case study, allows for a precise examination of the effects of sustainable modification on a Grade I listed building of significant socio-economic contribution, being a place of active worship, numerous pilgrimages, religious ceremonies and a renowned tourist attraction. This analysis will take shape through several methods: researching the specifics of the photovoltaic (PV) installation, exploring previously completed alterations to the building through a historical lens, and examining the level of intervention upon the existing building features, assessing both the impact on visible aspects and visitor experience.

Figure 1 – York Minster with Photovoltaic panels, conceptual sketch (Author's Own, 2024)

The Church of England – 2030 Net Zero Carbon Emission Plan

In response to the global climate emergency, the Church of England has set out a plan to achieve net zero carbon emissions by the year 2030, 'General Synod voted in February 2020 for the whole of the Church of England to achieve net zero carbon by 2030' (The Church of England, 2020). This aim involves mandating the use of energy from its cathedrals, churches, dioceses, schools and theological education institutions, implementing sustainable technology in building-specific ways to aid in lessening the current climate crisis. This response is conducted by the Synod – the Church of England Council, through concern for what the climate crisis may bring to the most economically vulnerable groups of society. Spokesperson for the council, Nick Holtam, The Bishop of Salisbury and lead bishop for the Environment, released the statement in which the Church of England claim that the climate crisis is an adversity in the face of social justice, 'This is a social justice issue, which affects the world's poorest soonest and most severely, and if the Church is to hold others to account, we have to get our own house in order' (Holtam, 2020). Here, he states the Synod's recognition that they are equally inclined to respond to the climate crisis in an urgent call to action, in which their 2030 net zero carbon emission plan begins to unfold.

In the subcategory of cathedrals within the decarbonisation project, York Minster is undergoing the installation of photovoltaics to the roof of the South Quire Aisle, originally dating from 1361. This includes attaching 199 panels that would generate a calculated 75,000 kilowatt-hours of power annually (York Minster, 2023). Considering the substantial role the Minster plays in defining the identity of York, examining the impact of photovoltaic installations on its cultural value is essential. This assessment aims to determine whether such installations enhance or diminish the Minster's cultural significance, amid growing public scrutiny of alterations to listed buildings, coupled with increasing concern over the climate crisis.

Literature review

Introduction

This section will examine the fabrication of cultural significance, specifically within historical settings as a derivative of place, identity and architectural form. It will also examine the role of listed buildings within a society that increasingly prioritises environmental consciousness, focusing on the contrasting perceptions of their position within the global climate crisis – questioning whether they should be actively integrated into response strategies, maintained in their present condition, or disregarded entirely. Specifically, it will examine the potential impact on the cultural significance of listed buildings when the response to the climate crisis involves implementing sustainable interventions on historical building fabric. It will compare anticipated outcomes stemming from attempts to mitigate the impacts of the climate crisis through the application of this method, with perspectives opposing the alterations.

Cultural significance of architectural heritage

'Cultural significance' is a commonly applied phrase, in which widely varying definitions exist across a range of disciplines. The term can be broadly defined as the gross estimated worth of an object, place, feature or event in terms of cultural prosperity. 'Value', as a crucial determinant of overall cultural significance, forces limitations on creating a precise definition of the phrase. This is due to the intangibility of 'value', as a form of measurement, making it wholly subjective as 'the judgement of value is merely the record of a feeling' (Lee, 1940). Some academics refer to the concept as 'spiritual', whereas others regard it as a more scientific notion that can be used as a tool in sociological experimentations, to further understand the relationship between culture and personal beliefs/values, 'the social world, otherwise random and chaotic, is meaningful because of the cultural lens through which people view it' (Griswold, 2012).

Since the meaning of the term varies among researchers, it is necessary to clarify here exactly what is meant in this article by the term 'cultural

significance', determining it in relation to 'architectural heritage', as a concept which aids in estimating the value of places which are likely to help an understanding of the past or enrich the present, and which will be of value to future generations (Rappoport, 2013).

In the 2008 book, *Managing built heritage: The role of cultural values and significance* by Derek Worthing and Stephen Bond, the authors assess the processes and management strategies of changing a historical environment in response to nature, use, technical and socio-economic advances. They begin by dissecting the notion of what makes a building of enough significance to be listed, in which Worthing and Bond argue that the majority of historical buildings are not completely appreciated for their heritage value, but are instead considered as 'a built envelope in which activities of one kind or another take place' (Worthing & Bond, 2008). Comparatively, they state the antithesis for some individual listed buildings, which are primarily noted for their architectural form, above function, or use. The authors accompany this outline by deconstructing the method of measuring cultural significance within the built environment, categorising it into multiple values that are assessed and recorded to determine the overarching cultural significance of the building. The issue stemming from the segmentation of cultural significance into distinct values is that sense of value is a completely subjective judgement, unique to the perspective of an individual. Therefore, the measurement of significance through a value-based assessment is only informative if the subjectivity and inconsistency of significance is considered, resulting in a requirement of further examinations of value.

According to authors Michael Pearson and Duncan Marshall, a more appropriate assessment of cultural significance involves evaluating a building's sensitivity to proposed alterations and its vulnerability to potential loss of value. Sensitivity ranges from high, where changes pose a significant threat to value, to low, where there is minimal threat. Ultimately, they determine: 'Understanding the relationship between values and impacts of change will help in modifying proposals and avoiding loss of significance' (Pearson and Marshall, 2012). This approach raises questions about navigating change to transition a building from past to future while preserving its maximum cultural significance. One method to incorporate this concept when analysing the anticipated impacts of a proposed alteration to a listed building in terms of cultural significance could be to review previously completed changes on the edifice. This examination would encompass an assessment of both their effects on visitor experience and visual aspects.

Sustainable intervention of historical buildings

'Sustainable intervention' is an umbrella term for integrated change, with the primary intention of increasing the sustainability aspects of the selected component. It is a response to the climate crisis, in which the built environment plays a significant role in the emission of carbon as a major source of energy consumption, with buildings being responsible for 39% of global energy-related carbon emissions (World Green Building Council, 2019). Through the utilisation of fossil fuels to supply their utilities such as heating, lighting, cooling and air conditioning, historical buildings account for approximately 28% of the United Kingdom's overall carbon release (Wise et al., 2021). In terms of the built environment, sustainable intervention refers specifically to how existing or proposed buildings can be developed to prioritise the well-being of the environment, so as not to disrupt or cause harm. Common examples include developing new methods of generating energy, such as the implementation of photovoltaics on an existing structure, or the harnessing of wind energy through placement of wind turbines.

In modern society, sustainable development and environmental protection are of progressive concern. There is ongoing debate about the responsibility to maintain energy-intensive historic buildings, given urgent research findings on the catastrophic effects of human exploitation of natural resources and fossil fuels on both humanity and the environment: 'This tectonic challenge is man-made. It is a civilizational, moral, and existential challenge – to humanity today, tomorrow, and for the future generations. If not addressed properly, the effects of this ecological challenge will be catastrophic to all future generations' (Aron, 2022). Contrastingly,

many advocate for preserving historical buildings in their original form as tangible links to our ancestors' lives. Believing that these structures offer insights into the past, enriching present-day society and fostering intergenerational connections. Furthermore, residents in the vicinity of a listed building may resist implementing sustainable interventions on said building due to personal attachments to its current form. Many locals may take pride in the city's cultural heritage, fostering a sense of protectiveness towards alterations to designated listed buildings, resulting in objections to change.

In cases of extreme distress, some individuals question the purpose of preserving listed buildings when the escalating climate crisis threatens the survival of humanity, suggesting we live in a 'time of unusually high risk of self-annihilation and long-term damage to the planet' (Fisher, 2020). This argument questions the prioritisation of preserving listed buildings, suggesting that society is failing to adequately address the climate crisis with the urgency it requires. However, humanity's failure to urgently address the severity of the climate crisis prompts the exploration of whether sustainable interventions on historic buildings can help raise awareness of climate change. The controversy associated with the sustainable modification of historic buildings, paired with the somewhat general knowledge of the difficulties faced in terms of planning approval when proposing change to a listed building, may suggest the severity of the climate crisis to the public. This transformation would elevate the listed building to a 'symbol/pioneer of change' in response to the climate crisis, prompting individuals to consider their own role in protecting the environment. As part of the Church of England 2030 Net Zero Carbon Emission Plan, Rt Revd Graham Usher and Rt Revd Dr John Thomson summarise this idea of advocacy within the sustainable modification of their historic churches, stating that all parts of the Church of England recognise the climate change crisis and the necessity of a strong, visible response to what is happening to our world (Thomson and Usher, 2020). In an ideal situation, these visual aspects of sustainable response would act as a point of realisation for many, prompting people to consider their own contribution to climate change, and how it can be eliminated.

Philosopher Derek Parfit encapsulates the weight of our responsibility for the prosperity of future generations by suggesting that as a modern-day society, we live during the 'hinge of history' – a hypothesis proposing a pivotal opportunity for change. Parfit argues that the rate of technical advancement is progressively increasing, proving that 'we shall soon have even greater powers to transform, not only our surroundings, but ourselves and our successors' (Parfit, 1984). The recognition of our responsibility towards society and future generations is underscored by the establishment of the Church of England's 2030 Net Zero Carbon Emission Plan. As previously indicated, the plan's motivations acknowledge the climate crisis as a matter of social justice that necessitates action. As stated by Holtam (2020), 'This is a social justice issue… we have to get our own house in order.' It could be suggested that Parfit's view regarding society's responsibility in securing the long-term future of our species, combined with the technological advancements of recent decades, and the human desire to want to protect historical buildings, can be used to formulate a justification of the sustainable modification of listed buildings.

Literature review summary

As discussed in the analysis of architectural 'cultural significance', altering a listed building to include elements not originally present leads to an irreversible change in its overall cultural significance. Whether this change is deemed positive or negative depends on individual perspectives, highlighting the importance of considering subjectivity and inconsistency in assessing significance.

The question of whether the interventions should occur is currently under active discussion. Some individuals oppose altering the building fabric due to personal attachments to its current form, while others may advocate for change in response to the climate crisis, viewing it as an opportunity to

transform the buildings into symbols of adaptation and progress.

Research methodology

In seeking to evaluate the addition of photovoltaics on a listed building in relation to its effects on intangible value, the previous investigation of the fabrication and measurement of cultural significance, specifically within historical buildings, will be vital. The management and measurement procedures that have been theorised by authors such as Pearson and Marshall to preserve this cultural significance, 'value-based' and 'level of sensitivity to change' assessments for instance, will be acknowledged within the case study of York Minster through an investigation of prior change to the building fabric.

More specifically, several previous interventions of York Minster, including the implementation of photovoltaic panels – a consequence of the Church of England's 2030 Net Zero Carbon Emission Plan – will be selected. This includes the creation of a timeline presenting a summary of previously completed interventions in context with the building's history, examining the outcomes of these changes, and uncovering any past assessments of its cultural value. A detailed assessment on the 'impact on experience' in relation to the changes made to the building's historic fabric will be carried out, through an analysis of the justification behind the alterations, which will aid in understanding any fluctuation of cultural significance.

The primary focus of this article is the integration of photovoltaic panels onto the roof of York Minster and whether this enhances or diminishes its cultural significance – exploration methods include on-site observations through visitations to York Minster, conducting interviews, and viewing the internal and external architecture. These on-site studies allow for an examination of whether the panels are visible from ground level, which would further inform any conclusions on the impact on cultural significance.

An additional method of analysis that could potentially contribute to any conclusions on the impact of cultural significance is a consideration of people's perspectives on the proposed sustainable intervention – specifically that of York residents in comparison to visiting tourists. This exploration will include the use of secondary data, which includes tourist brochures, visitor information booklets, advertisements for York and local newspapers.

The findings of this case study will then be analysed and questioned in relation to the prior investigations of the fabrication of 'cultural significance', and its presence within sustainable design. The organisation of the article in this way allows for a thorough investigation of the potential impact of photovoltaic installation on listed buildings, and ultimately whether it enhances or diminishes overall cultural significance. This will help ensure a balance between sustainability and heritage preservation – a concept that is of increasing urgency within the current climate crisis.

Case Study – York Minster

This case study has been organised into distinct subsections to facilitate a clear and comprehensive investigation into the effects of photovoltaic panels on the cultural significance of York Minster. These include a historical timeline, in which previously completed interventions will be selected and analysed, followed by an exploration of the aesthetical impacts of the panels regarding visibility factors and the associated perceptions.

Introduction

The Metropolitan Church of St. Peter, also known as York Minster, is an extremely dominant figure, omnipresent in the history of York and its skyline. It serves as both a substantial contributor to the city's economy, and as a site of active worship, the destination of countless pilgrimages and religious ceremonies, as a 'thriving church rooted in the daily offering of worship and prayer' (Diocese of York, Unknown). The edifice itself is a Grade I listed building, a palimpsest which boasts Gothic architecture, a Roman forum and environs of Anglo-

Saxon heritage, encompassing a wealth of historical value.

Figure 2 – York Minster as seen from York Bar Walls (Author's Own, 2024)

Figure 3 – York Minster as seen from ground level (Author's Own, 2024)

Timeline of York Minster's history

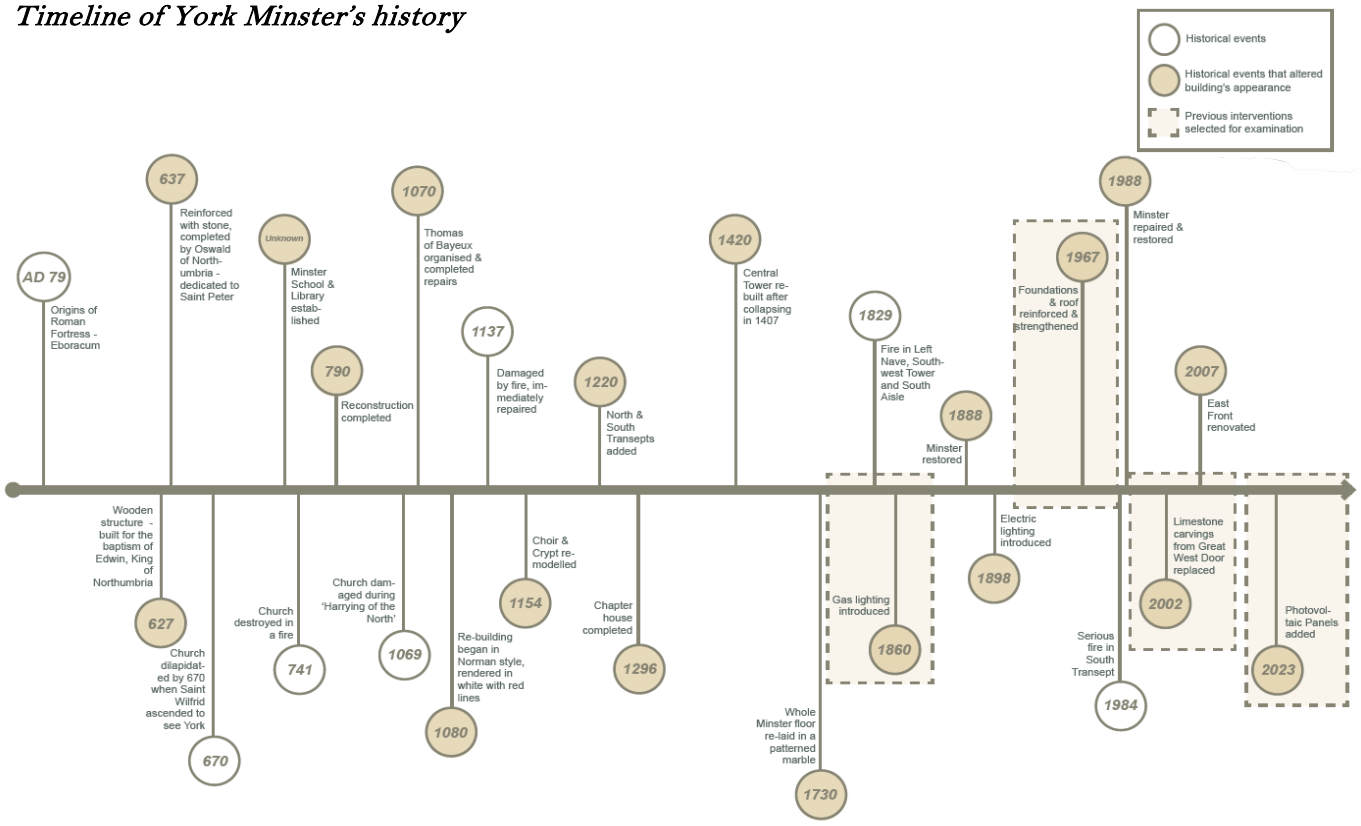


Figure 4 – Timeline of York Minster's History (Author's Own, 2024)

Previously completed interventions

When assessing the ramifications of installing photovoltaic panels on the roof of York Minster in relation to its broader cultural significance, it becomes essential to conduct a comprehensive evaluation and comparison of previously completed interventions to the structure's historic fabric. This analysis proves valuable in determining whether past interventions on the Minster share similar motives, particularly stemming from considerations related to the climate crisis and sustainability aspects. Additionally, it is contributory in examining past interventions that may be perceived as more drastic than the implementation of photovoltaic panels, and consequently the impacts that followed, as previously examined, authors Pearson and Marshall suggest an examination of potential loss of value can be conducted through examination of previous change (Pearson and Marshall, 2012). To assist this analysis, the utilisation of a table format is an effective method. This approach allows for the systematic breakdown of selected interventions from the Minster's timeline, enabling a substantial understanding of the rationale behind the alterations, their impact on visitor experience and consequently the conjected impact on cultural experience.

It is necessary to clarify in this context that the term 'cultural significance' retains the same meaning as previously defined, as a concept which aids in estimating the value of places which are likely to help an understanding of the past or enrich the present, and which will be of value to future generations (Rappoport, 2013).

Table 1 – Previously completed interventions (Author's Own, 2024)

Date	Intervention	Explanation	Impact on Experience	Impact on Cultural Significance
1860s	Implementation of gas lighting	Following the rise in usage of gas for lighting and heating, it was incorporated into the Minster due to the convenience and effectiveness in terms of providing light (Knowles, c. 1900–1929).	The use of artificial light resulted in several changes to the viewing experience of visitors. It improved the safety of accessing the Minster, due to the illumination of both internal passages by lamp and external walkways by streetlamp. It allowed for extended activities beyond the constraints of daylight hours, and in turn reduced the dependence on natural light, which can be obscured by weather conditions.	The addition of gas, specifically artificial light, could arguably increase or decrease cultural significance – completely dependent on perspective. Arguments that state this intervention decreases cultural significance could be based on the idea that historically, the Minster was lit by either daylight or candlelight – thus, using artificial light creates a discord between the user experience in the past, versus the user experience in post-gas installation. In contrast, this intervention could arguably increase cultural significance in the sense that it is in keeping with the technological advancements of society and thus preserves its relevancy in present day.
1967	Foundations & roof reinforced /strengthened	Failing foundations meant the East End leaned out 650mm at eaves level (Lewis, 2017), with settlement also causing widening cracks in the central tower. The Norman foundation walls were then drilled to link 400 stainless steel post-tensioning rods to new reinforced concrete foundation blocks.	These concrete blocks and steel rods are not visible from the ground-floor level, only from the undercroft and treasury level below. This engineering work directly led to the decision to create a museum on that floor, as the work required an excavation, which led to the discovery of new archaeological features which could be displayed.	Since the opening of the Undercroft and Treasury Museum, visitors can walk a route below ground level, in which they are surrounded by the reinforced stonework and archaeological history that was uncovered during the engineering work in 1967. This transparency that is present within the displaying of the reinforcements made to the original foundations could arguably add to the overall cultural significance (see Figures 5 and 6). Although these works have altered the original material, they were unavoidable due to health and safety concerns. This included the changes as part of the visitor experience, allowing the public to view the care and consideration that goes into the upkeep of the building, preserving its usage as a functional building of historical and religious significance.
2002–Present	Limestone carving replacement	Centuries of exposure to the elements, atmospheric pollution and major fires have left the limestone façade in a somewhat eroded state (see Figure 8). This is most apparent on the decorative stones,	The limestone replacements are located on all sides of the Minster and are initially a lighter colour until the stones become more weathered (see Figure 7). This makes the new carvings easy to locate when viewing the Minster.	The impact on cultural significance from this intervention could be argued both ways. In terms of adding cultural value, there is evidence that limestone restoration work on the building has been taking place since the eighteenth century, which could imply that the restoration and upkeep of the building is a tradition between generations – with each wave of repair bringing new interpretations of grotesques. Contrastingly, it could be

		such as the grotesques which once depicted medieval characters and are now hard to make out (see Figure 9). Stone masons are recreating and replacing around 3,500 stones from the Minster's exterior (University of York 2013).		argued that this intervention decreases the cultural significance as the weathering of the limestone presents the historical age and character of the building. However, it is also debatable that the replacement of eroded masonry neither increases or decreases cultural significance, but instead preserves it. This could be due to the nature of restoring the Minster to a state of how it was intended to look by our medieval counterparts.

Figures 5 and 6 – Stainless steel post-tensioning rod (Author's Own, 2023)

Figure 7 – New limestone grotesque figure (Author's Own, 2024)

Figure 8 – Eroded limestone, Minster's facade (Author's Own, 2024)

Figure 9 – Eroded limestone, Minster's Grotesques (Author's Own, 2024)

It is crucial to emphasise that verdicts of impact on cultural significance within the context of prior interventions are only informative when acknowledging the subjectivity and variability inherent in measuring significance, which is unique to individual perspectives. This examination of past

interventions underscores that significant alterations to the building will invariably influence the user experience, thereby impacting its overall cultural significance, whether positively or negatively, contingent upon individual viewpoints. However, irrespective of the necessity of these modifications, they were all undertaken with the aim of enhancing public welfare, and this was the motive for the integration of photovoltaic panels.

Photovoltaic panels

The decision to integrate photovoltaic panels onto the roof of York Minster runs alongside other decarbonisation initiatives for the structure, directly addressing the global climate crisis and aligning with the Church of England's 2030 plan to achieve net zero carbon emissions across its buildings. Recognising the substantial carbon footprint associated with the Minster estate, the installation of these panels is predicted by York Minster associates and stakeholders to serve as a lasting asset, contributing not only to the Minster's sustainable development but also playing a role in the broader objective of decarbonising the UK's grid: 'this installation will go a huge way in supporting the future care and conservation of this significant monument' (Cottrill, 2022).

The photovoltaic panels are situated on the roof of the South Quire Aisle, a section of the Minster that has undergone extensive maintenance for many years, due to, 'a perpetual cycle of stained glass and masonry repairs and restoration' (Caroe Architecture, 2022), which has required significant scaffolding in this area (see Figure 10). This provided an opportunity to utilise existing access to the roof, with no requirements for adjustments to the scaffolding for the installation of the 199 PV panels.

As per proposed Roof plan; (199 panels)

Annual PV Output (kWh/yr): 72,180

Capex PV (£): £147,750

Elec import offset (£/yr): £41,143 @56.6p (day) / 41.4p (night)/kWh

Simple payback (yrs): 3.4

CO_2 saving (kgCO2e/yr): 10,105

(Caroe Architecture, 2022)

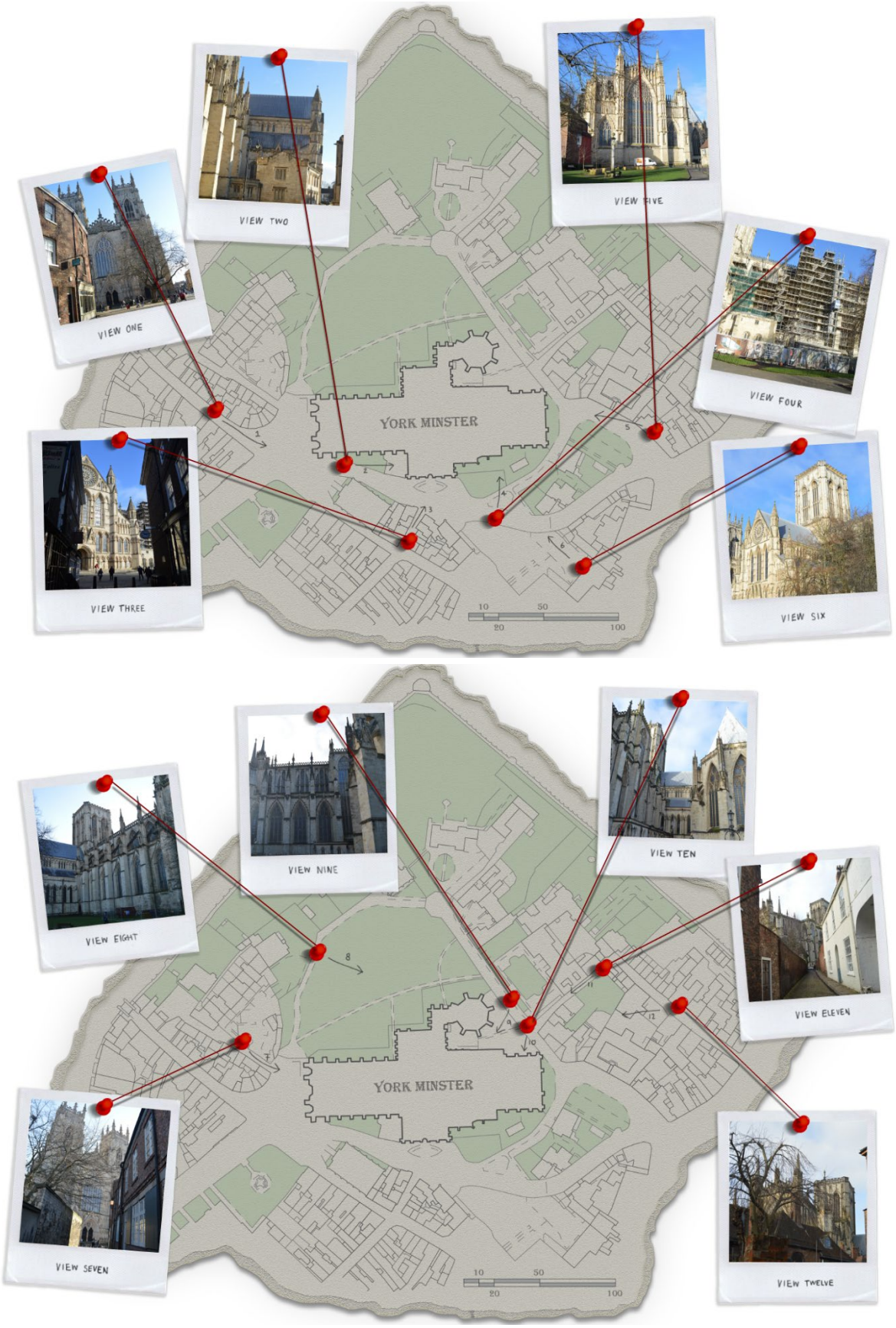
Figure 10 – York Minster South Quire Aisle in scaffolding (Author's Own, 2024)

Visibility aspects

One pivotal consideration associated with impacting cultural significance in the case of built heritage is the extent of visibility of the implemented alterations. As per Stephen Cottrell, Archbishop of York, the PV panels on the roof of the South Quire Aisle will be visible to observers; however, he claims that this visibility will not diminish the architectural integrity or heritage value of the edifice: 'The panels will be able to be glimpsed at ground level but will not detract from the cathedral's architecture or heritage values' (Cottrill, 2022). However, the reassurance regarding the safeguarding of the Minster's heritage and architectural integrity due to the installation of PV panels remains insufficient, as this statement is subjective, and to other individuals, the presence of the panels may adversely impact the aesthetic and intangible values of the building.

The visible aspects of the PV panels offer a variety of viewpoints regarding the installation. For example, residents of York may oppose physical alterations to the Minster due to their personal attachments to the building and its current appearance – considering its historical significance as a prominent landmark in the city. However, others may view the alteration as having a negligible effect on the architectural heritage, thereby not drastically affecting the overall cultural significance. Conversely, the contrast between contemporary solar technology and the historic fabric of the building, coupled with the challenges in obtaining planning approval for alterations to listed structures, suggests that the visibility of the implementation of PV panels may highlight the severity of the climate crisis to the public. Such transformations could elevate listed buildings to be interpreted as symbols of change in response to the climate crisis, a physical representation of humanity's pressing imperative to address the issue.

As part of the data collection process concerning this sustainable intervention and its effects on the cultural value of the Minster, on-site visits were conducted to assess the photovoltaic panels and evaluate their visual impact. An assessment of various perspectives from ground level surrounding the Minster also determined that the panels are not observable from alternate sides of the structure (see Figures 11 and 12). A significant limitation of this method was the presence of scaffolding on the South of the Minster, which ultimately obstructs any views of the panels. However, it is important to note that this scaffolding is temporary.



Figures 11 and 12 – Exploration of Minster views from ground level (Author's Own, 2024)

Discussion

In order to respond to the research enquiry, this discussion has been organised into the following sections: 'People's perceptions', 'Historical controversy', and 'A pioneer for change'. This framework facilitates a more in-depth evaluation of previously explored topics concerning York Minster; refining the earlier, more generalised approach that aimed to investigate various perspectives on the matter. The information derived from the case study will be utilised to refine and enhance any conclusions that can be deduced in answering the question at hand, that is, 'Does the integration of photovoltaics diminish the cultural significance of York Minster, or does it enhance its value within a society that is progressively prioritising sustainability and environmental consciousness?'.

People's perceptions

Through the conflicting arguments of praise and appeal regarding the retrofitting of listed buildings as a response to the global climate crisis, it becomes apparent that many individuals share contrasting opinions on the matter. In the case of the integration of photovoltaic panels onto the roof of York Minster, an initial observation could suggest that a significant divide in viewpoint is between the residents of York and the visiting tourists.

In this instance, it could be considered that the residents may be more inclined to oppose the implementation of sustainable interventions on the Minster, due to personal attachments to the building in its current form. Many inhabitants of the locality take great pride in the cultural heritage of their city, some may even foster a sense of protectiveness towards any alterations made to designated listed buildings – leading to objections and opposition to change. This dissatisfaction is evident in a multitude of public comments found in online articles published by York newspapers, which detail the installation of the photovoltaic panels on the roof of the Minster. This apparent discontent further escalated to the extent that individuals then took to expressing their disapproval by means of written letters, subsequently featured in the *York Press*. The collective sentiment is succinctly captured in this line from one of the published letters: 'solar panels on York Minster are neither essential nor appropriate and it is clearly a daft idea. The Dean and Chapter have a duty to preserve and protect that building, not despoil it' (Laverack, 2022). This is not to imply that individuals opposing the installation of photovoltaic panels are indifferent to the catastrophic global impacts of the climate crisis; instead it aims to present an alternative perspective that takes into consideration the personal significance of heritage.

Conversely, tourists visiting the area may prioritise the broader context and the Minster in its entirety, potentially displaying less concern for such changes. This perspective can be attributed to the brief duration of their visits, leading tourists to overlook arguably 'smaller' details such as photovoltaic panels. This observation becomes apparent upon examination of the content presented within various tourist information brochures dedicated to York. Each brochure highlights the Minster as the central attraction to the city, with a primary emphasis on its architectural role as a cathedral, and no mention of sustainable interventions: 'Discover one of the world's most magnificent cathedrals, a masterpiece in stained glass and stone and a sacred space' (Visit York, 2023). Furthermore, upon examination of the views of York Minster from prominent tourist locations such as York Bar Walls and York Train Station, it becomes evident that finer details like the photovoltaic panels cannot be seen from these areas (see Figure 13), exemplifying the likelihood that a tourist would disregard the significance of such architectural interventions, instead focusing on the expansive silhouette of the structure.

Therefore, from the standpoint of a tourist, it could be contended that the implementation of sustainable interventions during the retrofitting of a listed building such as York Minster has a marginal impact on its cultural significance.

To summarise, a potential source of the variation in opinion regarding the sustainable intervention of York Minster lies in the opposing perspectives of

residents and tourists. Residents may resist change in the form of photovoltaic panels based on personal attachments to building heritage, while tourists may exhibit less interest due to the brief nature of their stay. It is crucial to note, however, that these observations should not be generalised to encompass the sentiments of all York residents and visiting tourists.

Figure 13 – Exploration of Minster Views from York Bar Walls (Author's Own, 2024)

Historical controversy

Resistance to the incorporation of new interventions into the Minster's building fabric is not unprecedented. Much like the opposition to the installation of photovoltaic panels on the roof of the Minster, sentiments of discontent were voiced over a century ago in response to comparable interventions. This is most apparent through records that detail the installation of gas lighting to the building's interior spaces, which replaced the traditional usage of candlesticks. Records from J. W. Knowles' book *Historic notes on York Minster* state that gas was introduced to the building in 1824; however, it was not utilised for lighting until the early 1860s. At this time, the switch from candlelight to gas is shown to have been largely rejected, with Knowles stating, 'Altogether the gas seems in ill accordance with the venerable building in which it illuminates' and 'Wax lights, so appropriately used in the solemn service of the

Church from the very foundation of the fabric, gave place to the unsuitable glare of modern gas burners' (Knowles, c.1900–1929). These quotations are comparable to contemporary debates surrounding PV panels, as some proclaim that the incorporation of modern technology on such a historically significant building is inappropriate, underscoring the challenge of achieving universal satisfaction, despite the benefits that can be accomplished through such change.

Continuing along the Minster's historical timeline, the introduction of electricity to replace gas lighting was also met with resistance. This sentiment is evident within the quotation from the Durham County Advisor: 'York Minster has now a complete installation of the electric light, the latter being used for the first-time last Sunday… with marked effect' (DCA, 1900). This rejection serves as an intriguing parallel, highlighting the persistent nature of public concern regarding alterations to listed buildings. There is also irony in the way that the gas lighting, which was once somewhat rejected, was now favoured in the face of change. It emphasises the notion that such opinions are neither inherently right nor wrong, given that the assessment of impact on cultural significance remains entirely subjective. Visual elements of these contemporary alterations remain evident in the Minster's structure today (see Figures 14, 15 and 16); however, they no longer command significant public attention, as visitors have grown accustomed to the presence of these alterations.

It is equally interesting to examine how alterations to historical building fabric may face resistance, despite how substantial the benefits of said alterations may be to visitor experience. This impression aligns with the perspective previously discussed, where philosopher Derek Parfit claims that the pace of technological progress is continuously quickening (Parfit, 1984). Parfit suggests that this acceleration presents even more opportunities to benefit both present and future generations, advocating for the embracement of technology due to its potential to aid society, specifically visitor experience in the instance of York Minster. For instance, the introduction of gas lighting in the 1860s not only enhanced safety and accessibility within the Minster in terms of strength of illumination in comparison to candlelight, but it also facilitated late-night church services. These services commenced with the aim to 'induce the working classes more especially to attend divine worship', and it is said that such services would not have been possible without an improvement in lighting and the introduction of heating (Jacob et al., 1961) – both of which were provided by the installation of gas. In a similar scenario, the addition of PV panels onto the Minster's roof in the year 2023 has multiple benefits as previously mentioned, such as the predicted generation of 75,000 kilowatt-hours of power annually (York Minster, 2023). This not only diminishes the reliance on finite fossil fuels, but also lowers energy expenses, allowing resources to be reallocated to other aspects of the building's overall upkeep. It is imperative to note here that the repeated resistance to alterations upon York Minster presented by some individuals does not necessarily imply a lack of consideration to the benefits. Conversely, it suggests a concern for the building in the sense of both tangible and intangible value, which, as previously stated, is entirely subjective.

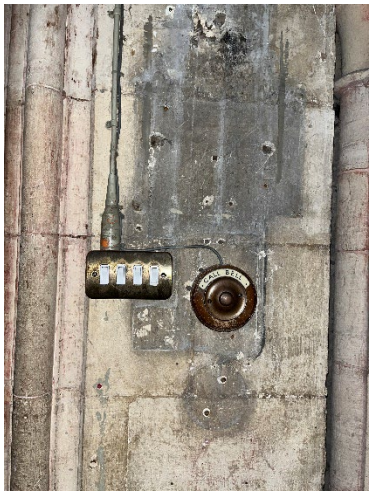


Figure 14 – Example of installation of electrical lighting in present day (Author's Own, 2024)

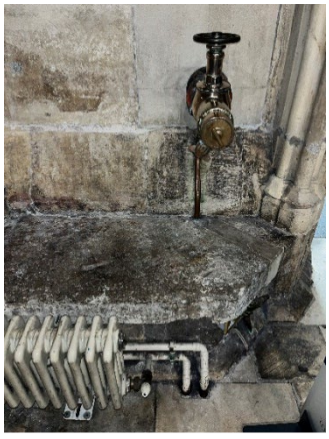


Figure 15 – Example of installation of gas pipework in present day (Author's Own, 2024)

Figure 16 – Example of installation of electricity in present day (Author's Own, 2024)

A pioneer for change

During the examination of the contrasting arguments surrounding the topic of sustainable intervention of listed buildings, the perspective emerged that suggests the visual aspects of such alterations can serve as a realisation of the severity of the climate crisis for many individuals. As previously stated, the PV panels on the roof of the South Quire Aisle will be visible to observers, and considering this viewpoint, the juxtaposition between contemporary solar technology against the building's historic fabric can be seen as a symbolic indication of the urgent need for humanity to respond to climate change.

The building's inclusion in this symbolism implies its role as a 'pioneer for change', in which the phrase 'pioneering York Minster', is used sparingly in the announcements of the installation of the PV panels on multiple websites, including the Archbishop of York, with an article titled, 'Pioneering York Minster leads way with photovoltaic roof installation plan' (Cottrell, 2022). This notion of the building's advocacy for sustainability was also mentioned during an interview with Alex McCallion, Director of Works at York Minster, who described how the Minster (organisation) strives to lead by example with the benefit of the public at the forefront (A. McCallion, personal communication, November 29, 2023), when asked how the photovoltaic panels would affect the visual aesthetics of the building, especially from public viewpoints. McCallion's reference to the motivations behind the changes within the Minster being linked to public benefit encapsulates the rationale behind the Church of England's 2030 Net Zero Carbon Emission Plan, driven by concerns about the potential impacts of the climate crisis on society.

The success of this aim to encourage people to respond to the climate crisis, particularly through the sustainable intervention of listed buildings through the implementation of photovoltaic panels, is yet to be witnessed. However, the Minster successfully acting as a pioneer for change is not unprecedented – with the installation of electrical lighting in the year 1900 sparking conversation of when other cathedrals will do the same: 'York Minster has now a complete installation of electric light… many would like to know when the Dean and Chapter of Durham intend to follow suit' (DCA, 1900).

Conclusion

The primary objective of this research was to evaluate the addition of photovoltaic panels onto a listed building, specifically in relation to the impact this has on cultural significance, within a society that progressively prioritises sustainability. This comprehensive approach provided multiple perspectives on the Minster's overall cultural significance considering this implementation.

One of the key findings came through the investigation of people's perspectives on the installation of PV panels on the Minster, due to the broad spectrum of opinions on the matter. An

observation suggesting that a significant divide in opinion between residents of York and visiting tourists was explored, through the utilisation of both local newspaper articles and tourist brochures. It was inferred that residents may exhibit resistance to change in the form of photovoltaic panels due to personal attachments to building heritage, whereas tourists may demonstrate less interest given the transient nature of their visit.

Further analysis was conducted on the demonstrated resistance to change regarding the building, delving into historical instances of rejecting technical advancements to the structure. It was determined that similar to the resistance against installing photovoltaic panels on the Minster's roof, sentiments of dissatisfaction were expressed over a century ago regarding analogous interventions, such as the introduction of gas lighting, followed by the transition to electrical lighting. This underscores the persistent nature of public apprehension regarding alterations to buildings of historical significance.

The notion of the Minster's role as a 'pioneer for change' was also examined, exploring how in an optimal scenario, the visual aspects of the PV panel implementation are anticipated to serve as a catalyst for realisation, resonating with observers as they witness the integration of contemporary sustainable technology into a building of meticulously preserved heritage, despite its minimal visual cohesion with the historic fabric. Consequently, this may prompt individuals to contemplate their own role in contributing to climate change and explore potential avenues for mitigation.

Ultimately, the considerations examined regarding the conflicting viewpoints on the impacts of this implementation on the overall cultural significance of York Minster should all be duly acknowledged. As previously noted, opinions are entirely subjective, and as such, these perspectives are neither inherently right nor wrong. However, against the backdrop of the global climate crisis, the proactive measures undertaken by the Minster (organisation) to mitigate carbon emissions and reduce the building's energy consumption warrant commendation. The examination of previously completed interventions within the Minster has demonstrated that impact on experience is subjective, along with the impact on cultural significance. Historical motivation of past interventions was localised to primarily benefit those who used the Minster, whereas the implementation of photovoltaic panels addresses the needs of a global issue.

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Figure List

Figure 15 – Author's Own Image

Figure 16 – Author's Own Image